# Appendix C
# Snow Storage Site Retrofit Monitoring Plan

Table of Contents

# C. Snow Storage Site Retrofit Monitoring Plan

## 1.0 Introduction

### 1.1 Background

The Municipality of Anchorage (MOA) has conducted a number of studies to assess deicer and snowmelt impacts on receiving waters. These assessments provide quantitative, site-specific local data. In addition, these assessments were informed by reference to the literature on similar research.

In 1998 the MOA sampled snowmelt at four snow storage sites (Commercial Drive, Tudor Road, Sitka Street, and Anchorage International Airport), each with snow hauled from different types of land uses (MOA, 1998). This study was specifically targeted to assess the potential for meltwater from snow storage sites containing magnesium chloride deicer to impact Anchorage surface and subsurface receiving waters.

As a follow-up to the 1998 study, in 1999 the MOA sampled snowmelt at two snow storage sites (North Mountain View and Tudor Road) to determine whether the 1998 data accurately represented chloride impacts from snow site meltwater (MOA, 1999). In addition, this study monitored chloride concentrations in snowmelt runoff from three street sites and in receiving waters. This study estimated concentrations of anions and cations in snowmelt from samples to estimate the relative proportion of chloride, magnesium, and sodium in meltwater and receiving waters.

In 1999 EPA issued a National Pollutant Discharges Elimination System (NPDES) stormwater discharge permit (AKS 052558) to the MOA and the Alaska Department of Transportation and Public Facilities (ADOT&PF). The permit required these co-permittees to assess the effects of street deicers on water quality and to require the use of Best Management Practices (BMPs) at snow storage sites. Based on the permit requirements and building on monitoring efforts in 1998 and 1999, the MOA conducted several more years of monitoring at snow storage sites.

In 2000 the MOA conducted a study that estimated snow mass in the snow pack at three Anchorage snow storage sites and assessed pollutant concentrations, including chloride and turbidity, in the snowmelt prior to settling or dilution in the detention basins (MOA, 2000b). In 2001 the MOA also conducted monitoring of snow storage site meltwater at the Tudor snow storage site.

Peak chloride and turbidity values from these past studies are summarized in Table C-1. Chloride concentrations were found to peak early in the monitoring period at approximately 400 mg/L at both the Tudor and Sitka Street snow storage sites in 2000 (MOA, 2000b) and at approximately 1,300 mg/L at the Tudor site in 2001 (MOA, 2001). Chloride concentrations at both sites diminished to less than half their peak concentrations within 4 to 10 days (MOA, 2000b and 2001). Flows from the sites peaked after peak chloride concentrations; and turbidity peaked toward the end of the melt period (MOA, 2001b).

The results of these studies show that the peak chloride concentration precedes the peak flow. This is thought to occur because of the high solubility of sodium and magnesium chloride.

## Table C-1. Previous Sampling Results

| Snow Site | Monitoring Location Description | Monitoring Site ID | Maximum Chloride Values: From correlation with specific conductance | Maximum Chloride Values: Based on laboratory analyses | Maximum Turbidity Values: Field Sampling Results |
|---|---|---|---|---|---|
| | | | mg/L | mg/L | NTU |
| **2000** | | | | | |
| South Anchorage | Meltwater discharger to wetlands from adjacent ponding, east-central side | SANC01A | 338 | 349 | 5800 |
| | Meltwater discharge to wetlands directly from snow mass - 10 ft north of east pond | SANC01B | 333 | not sampled | 30 |
| | Meltwater discharge to wetlands from snow mass - 30 ft north of east pond | SANC01C | 190 | not sampled | 11 |
| | Meltwater discharging from NE corner of site | SANC02 | 266 | not sampled | 299 |
| | Meltwater discharging from northern side about 50 ft from NE corner | SANC03 | 216 | not sampled | 299 |
| Sitka Street | Meltwater entering detention pond from snow mass before the fence | SI01 | 392 | 405 | 267 |
| | Meltwater discharging by the entrance gate just prior to off-site discharge | SI02 | 187 | 158 | 50 |
| | Detention pond discharge | SI03 | 195 | not sampled | 50 |
| Tudor Road | Discharge from NW edge of snow site into detention basin | TU01 | 436 | 428 | 3500 |
| | Discharge from north central portion of snow site into detention basin | TU02 | 202 | 349 | 337 |
| | Discharge from Eastern edge of snow site into detention basin | TU03 | 226 | 333 | 353 |
| **2001** | | | | | |
| Tudor Road | Discharge off NW edge of snow site into detention basin | TU01 | 1338 | 1160 | 761 |
| | Discharge from pilot area V-swales | TU03 | 821 | not sampled | 8.1 |
| **2013** | | | | | |
| Tudor Road | Discharge from NW edge of snow site | TU01 | 850 | not sampled | 550 |
| | Discharge from pilot area V-swales | TU03 | 185 | not sampled | 65 |
| Spruce Street | Meltwater from basin pond | SprWR1 | 50 | not sampled | 26 |
| | Discharge from distributory weir | SprWR2 | 10 | not sampled | 23 |

Turbidity was found to follow the peak flow. This is thought to occur because the particulates are retained within the snow pack forming a crust on the snow which is the last to enter the discharge stream (MOA, 2000a). Based on these observations and literature information, the MOA proposed a treatment train of V-swales and detention basins as snow storage site BMPs.

In 2001, MOA studied the impact of a set of V-swales (also called V-pads) in a pilot area at the Tudor snow storage site. Installation of the pilot V-pad was intended to reduce turbidity in the snowmelt discharge. This assessment evaluated turbidity and chloride in the discharge over approximately six weeks of snowmelt and quantitatively assessed the effectiveness of the snow storage retrofit by measuring chloride and turbidity in the meltwater discharged prior to the detention pond (MOA, 2001). Study results (MOA, 2001) showed that turbidity in the discharge from the V-pad area of the snow storage site was reduced by an average of four times that of the standard practice storage area.

The NPDES stormwater permit issued in 2009 and reissued in 2015 to MOA is now administered under the Alaska Pollutant Discharge Elimination System (APDES). It requires quantitative assessment of the effectiveness of two full-scale snow storage retrofits by measuring chloride and turbidity in the meltwater discharged from the snow storage sites.

This study will evaluate the effectiveness of the snow storage area BMPs (specifically the V-pads and detention basins) at reducing turbidity and chloride concentrations in snowmelt runoff leaving the snow storage sites. In addition to the control provided by the V-pads and detention basin BMPs, results of this study will also qualitatively reflect the effects of operational BMPs. These include changes in use of deicing chemicals in the source areas of snow destined for these sites and the placement of snow in these sites (including such considerations as sequencing of site fill, setbacks from berms, and height of the snow mass). The results of this study may also reflect season to season variability in snow filling operations due to the timing and amount of snowfall and application of sand and deicer in the Anchorage bowl.

## 1.2 Problem Definition

During the winter, MOA and ADOT&PF use de-icing and anti-icing agents that contain sodium and magnesium chloride to improve driving conditions. The salts mixed with traction aggregate applied to streets (to prevent clumping of the aggregate and to enhance bonding of the aggregate to snow and ice) and applied directly to Anchorage streets may be removed when snow is plowed and hauled to one of several snow storage sites within the Anchorage area. Data suggest that while most of the de-icing agents (sodium and magnesium chloride and aggregate) remain on or near the street application sites, a fraction of particulate and other street pollutants is incorporated into the stored snow (MOA 1998).

During spring thaw, the salts and particulates drain from the snow storage sites and may flow into local streams. Concern over the quality of the discharge from the snow storage sites resulted in the MOA retrofitting the snow storage sites at the Tudor Street snow storage site with windrows of V-shaped swales (or V-pads) for snow placement and detention basin. The pilot study of the Tudor site (MOA, 2001) indicated water quality improvements, specifically in reduced turbidity of the snowmelt discharge.

This study seeks to quantify changes in chloride and turbidity in meltwater discharged from retrofitted or newly designed MOA and ADOT&PF-owned or operated snow storage sites to determine whether the BMPs reduce turbidity and chloride concentrations that are discharged to the receiving waters.

### 1.3 Goals and Objectives

The goal of this monitoring plan is to evaluate two snow storage areas to determine the effectiveness of the BMPs at reducing chloride and turbidity in the snowmelt runoff. Specific objectives are to measure specific conductance (as a surrogate for chloride) and turbidity of the snowmelt discharged at two snow storage areas that have been constructed or retrofitted with V-pads and detention ponds. This data will be used to determine whether the BMPs reduce turbidity and chloride concentrations when compared to historical data gathered from these sites or similar non retrofit sites.

## 2.0 Description of Program and Rationale

### 2.1 Sampling Design

MOA will monitor the discharge of snowmelt at two snow storage sites that have been retrofitted with BMPs. The locations of the two sites, the Tudor Road and Spruce Street snow storage sites, are depicted in Figures C-2 and C-3. If MOA identifies an alternative site for either of these, the site will have equivalent BMPs and sampling regime.

The Tudor snow storage site is located southwest of the intersection of Tudor Road and Campbell Air Strip Road. The site has a relatively high slope and historically turbid meltwater (MOA, 2000b). The Tudor site meltwater discharges into an unnamed branch of Chester Creek.

The Spruce Street snow storage facility is located south of Dowling Road between Elmore Road and Spruce Street.

Two types of BMPs have been installed at the Tudor site. The first is an expansion of the pilot study V-swales that now encompass the entire area where snow is placed in windrows. As the snowmelts, particulates that cause turbidity are retained within the swales. The V-pad discharges into the second BMP, a detention pond, which further removes solids by settling and serves to ameliorate the peak chloride concentrations.

The Spruce Street site was constructed in 2012 with V-swale technology on the snow pad and a retention pond to receive melt water from the entire snow storage site. The pond discharges through a weir into a second small settling pond before it is dispersed into an adjacent wetland.

During all sampling events, MOA will monitor specific conductance and turbidity at select stations, shown in Figures C-2 and C-3. Measurements will be taken using a Hanna Combo pH & EC, or similar testing probe, to measure specific conductance as a surrogate for chloride concentration and a Hach 2100P for directly measuring nephelometric turbidity.

To determine the effectiveness of the BMPs at retaining particulates, MOA will monitor turbidity at representative V-pad outlet channels at the two snow storage sites. For the Tudor site, turbidity measurements will be compared to the data obtained in 2001 and 2013 at that site (MOA, 2001 and 2013). For the Spruce Street Station site, turbidity data obtained at the V-pad outlets will be compared with the data gathered from the 2013 study MOA, 2013). Turbidity will also be monitored as it discharges from the detention ponds. MOA will monitor turbidity by obtaining a minimum of weekly grab samples.

To determine the effectiveness of the detention ponds at ameliorating chloride concentrations, the V-pad outlets and the discharge from each pond will be monitored for specific conductance (a surrogate for chloride). The V-pad outlets will be monitored for specific conductance to establish chloride concentrations entering the detention ponds.

## 2.2 Schedule of Sampling

MOA will obtain daily or weekly grab samples during afternoons for field and laboratory analysis.

**Figure C-1**

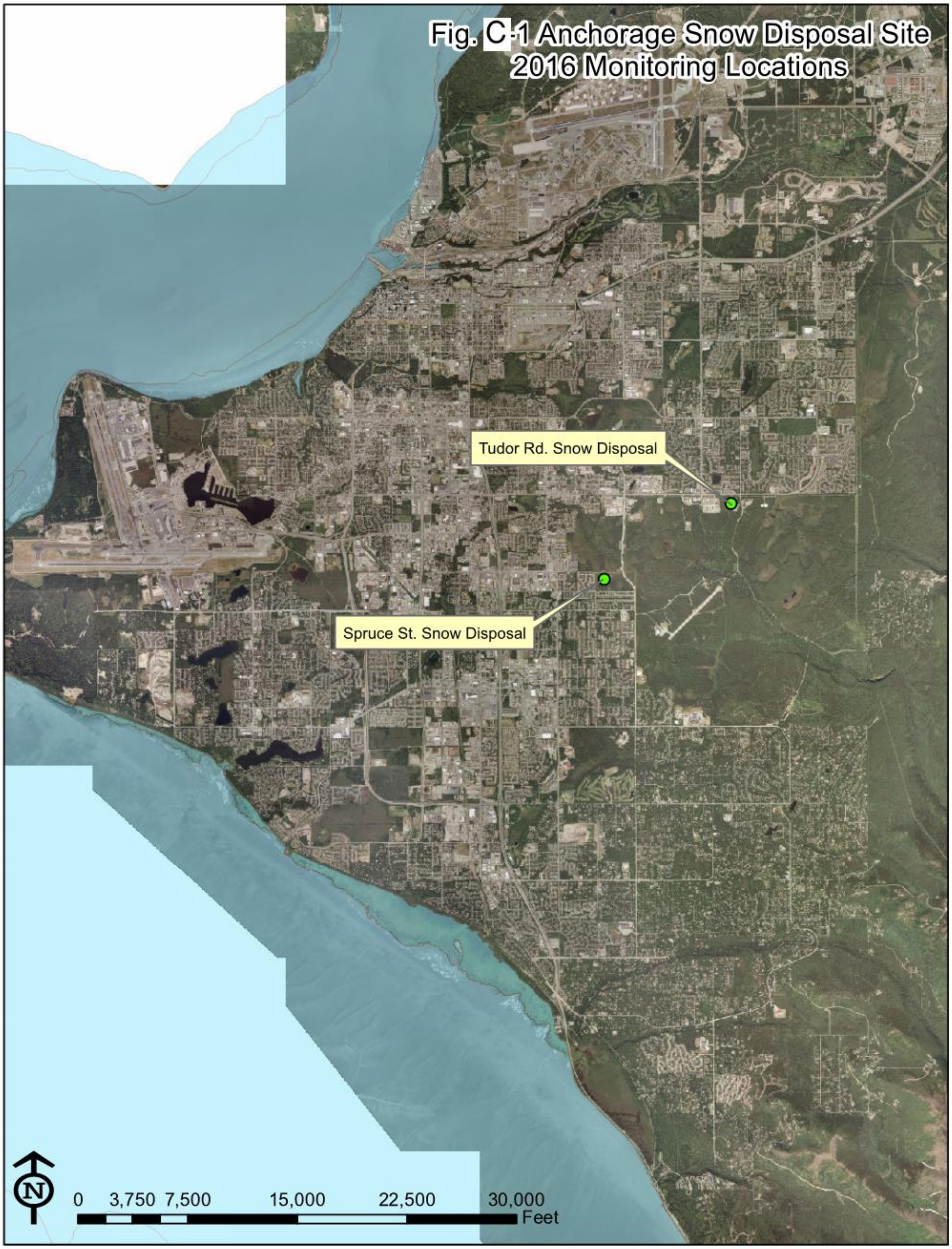
Fig. C-1 Anchorage Snow Disposal Site
2016 Monitoring Locations
Tudor Rd. Snow Disposal
Spruce St. Snow Disposal
N
0 3,750 7,500 15,000 22,500 30,000
Feet

## Figure C-2

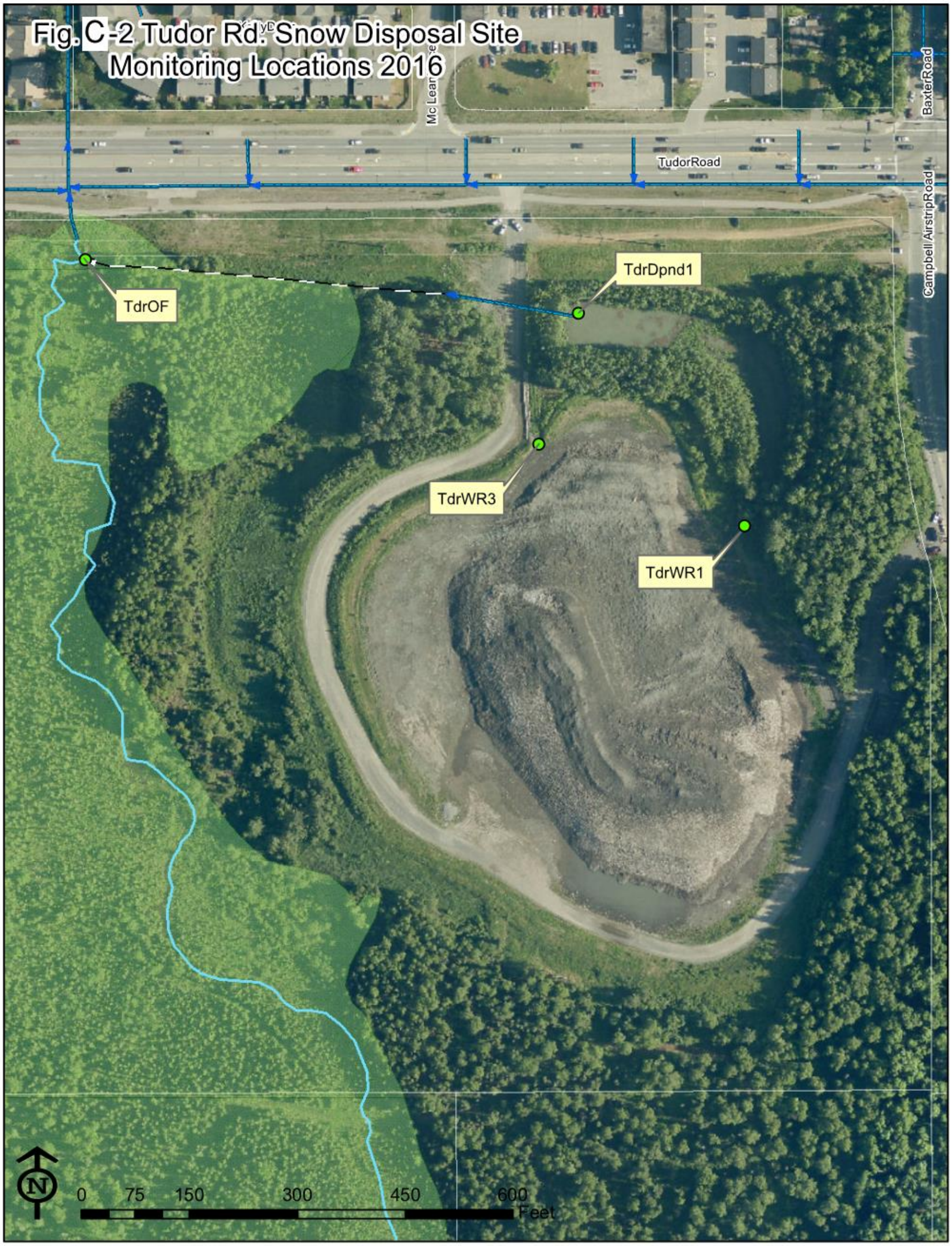
Fig. C-2 Tudor Rd. Snow Disposal Site
Monitoring Locations 2016
Mc Lean
Baxter Road
Tudor Road
Campbell Airstrip Road
TdrDpnd1
TdrOF
TdrWR3
TdrWR1
0
75
150
300
450
600
Feet

## 3.0 Monitoring Locations

Runoff from Tudor snow storage site flows to the pond through three outlets depicted on Figure C-2 as TU01, TU02, and TU08 for the Tudor Road site. The discharge from the detention ponds will be monitored at TU04

Monitoring from Spruce Street snow site flows into the pond depicted on Figure C-3 as SprWR1 and east through a distributory weir labeled SprWR2 into an adjacent wetland.

For each of the monitoring locations, Table C-2 summarizes the purpose of monitoring and criteria for selection of the specific sites.

**Table C-2. Sampling Site Representativeness**

| Map ID | Monitoring Site ID | Monitoring Purpose | Criteria for Site Selection |
|---|---|---|---|
| TdrWR3 | TU01 | Characterize snowmelt quality after V-swales but before pond | Downstream of V-swales, and upstream of pond |
| TdrDpnd1 | TU04 | Characterize snowmelt quality after pond treatment | Downstream of pond |
| TdrOF | TUOut | Characterize snowmelt quality discharge | Discharge Site |
| SprWr2 | SprWR1 | Characterize snowmelt quality after V-swales but before pond | Downstream of V-swales, and upstream of pond |
| SprWet3 | SprWet3 | Characterize snowmelt quality after pond treatment at distributory weir | Downstream of V-swales and pond |

*Snow loading in 2017 made TdrWR1 inaccessible. It is eliminated as a sampling site.

**The mapped site SprWr1 is redundant with SprWr2, it is eliminated as a sampling site.

## Figure C-3

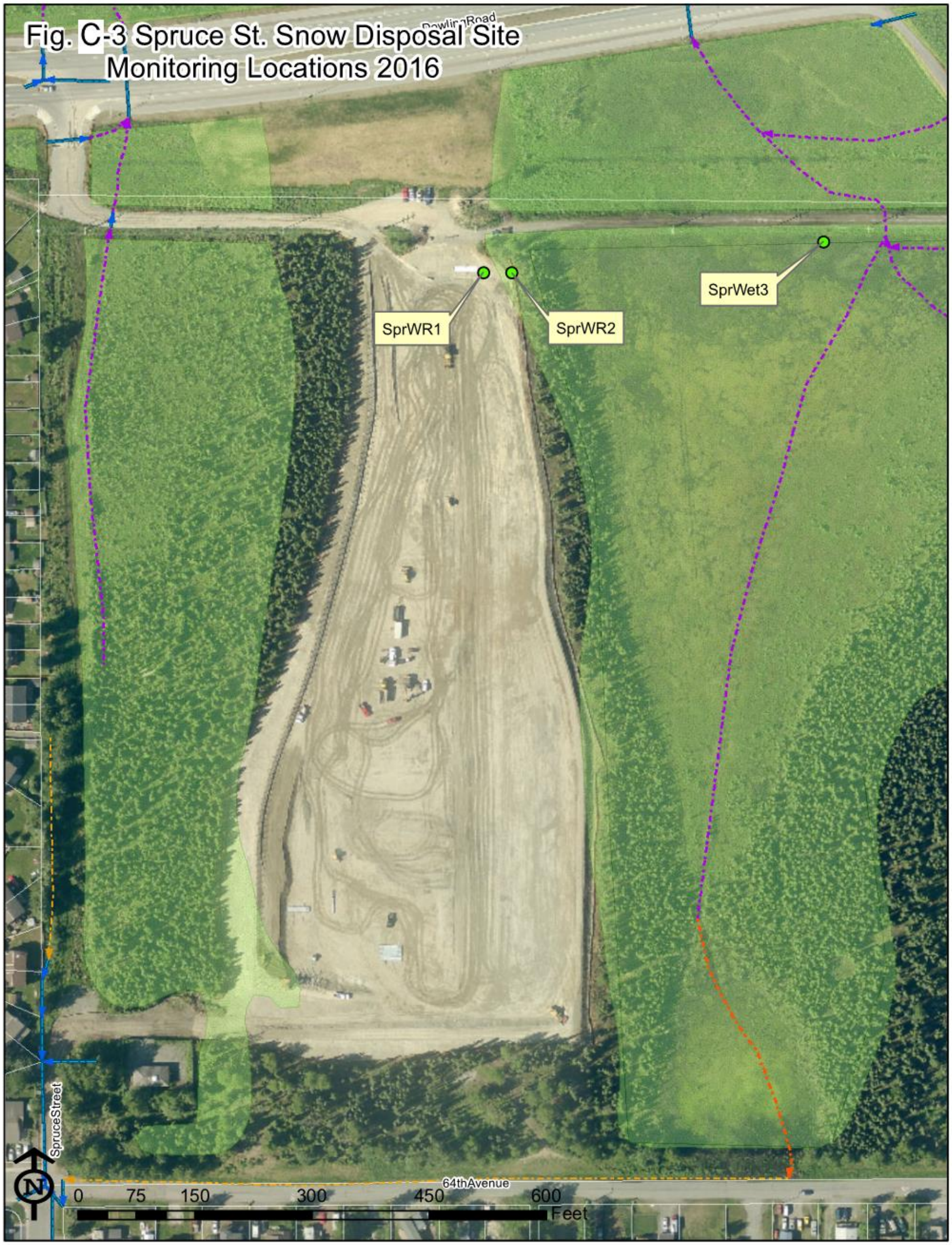
Fig. C-3 Spruce St. Snow Disposal Site
Monitoring Locations 2016
DowlingRoad
SprWR1
SprWR2
SprWet3
SpruceStreet
64thAvenue
0 75 150 300 450 600
Feet

# 4.0 Parameters to be Measured and Methods

Table C-3 summarizes the samples that will be taken at each location, and Table D-4 lists the parameters that will be monitored at each sample location, the sample types, frequencies, and times at which samples will be obtained and the total number of measurements that will be compiled from the sampling efforts.

Method detection limits, practical quantitation limits, and precision, accuracy, and completeness criteria are summarized in Table C-4 and provided in the Quality Assurance Project Plan (QAP).

**Table C-3. Sampling Summary**

| | Specific Conductance | Turbidity |
|---|---|---|
| Site ID | Grab | Grab |
| TU01 | X | X |
| TU04 | X | X |
| TUOut | X | X |
| SprWR2 | X | X |
| SprWet3 | X | X |

## Table C-4. Site Sampling Schedule

| | Monitored Parameters | Type of Sample | Frequency | Sample Time | Total No. of Measurements |
|---|---|---|---|---|---|
| TU01 | Specific conductance, Chloride | G | 1 - 2 times/week | Between 1 and 5:30 pm | ~14 |
| | Turbidity | G | 1 - 2 times/week | Between 1 and 5:30 pm | ~14 |
| TU04 | Specific conductance, Chloride | G | 1 - 2 times/week | Between 1 and 5:30 pm | ~14 |
| | Turbidity | G | 1 - 2 times/week | Between 1 and 5:30 pm | ~14 |
| TUOut | Specific conductance, Chloride | G | 1 - 2 times/week | Between 1 and 5:30 pm | ~14 |
| | Turbidity | G | 1 - 2 times/week | Between 1 and 5:30 pm | ~14 |
| SprWR2 | Specific conductance, Chloride | G | 1 - 2 times/week | Between 1 and 5:30 pm | ~10 |
| | Turbidity | G | 1 - 2 times/week | Between 1 and 5:30 pm | ~10 |
| SprWet3 | Specific conductance, Chloride | G | 1 - 2 times/week | Between 1 and 5:30 pm | ~10 |
| | Turbidity | G | 1 - 2 times/week | Between 1 and 5:30 pm | ~10 |

# 5.0 Sampling Methods

## 5.1 Site-Specific Sample Methods, Handling, and Field QC

Grab samples for turbidity, and specific conductance will be collected each week in the afternoon when diurnal flow is the greatest. The specific conductance meter will be checked against certified calibration solutions prior to use.

After ensuring that the turbidity and specific conductance meters are functioning, the water samples will be collected using a grab sampler from the water flowing in the melt water channel to represent the discharge. This is accomplished by holding the grab sampler below the flowing water. If no water is flowing, no sample will be taken. Sample crews should take care not to disturb any sediment accumulated in the channel when collecting a water sample. Field equipment will be used to measure turbidity and specific conductance. Field measurements will be recorded in the field log book.

## 5.2 Site-specific, Non-Direct Measurements

Observations of operational BMPs will be recorded at the time of sampling startup. Observations include: placement of snow including sequencing of site fill, estimated height of the snow mass and any other relevant information available.

## 5.3 Sample Preservation and Packing

The turbidity and specific conductance measurements will be recorded in the field, eliminating the need for preservation and packing.

## 5.4 Field Instrument Calibration

Instrument calibration is addressed in Appendix H of the QAPP. Each field instrument will be calibrated according to the manufacturer's directions and records of calibrations will be maintained in the project-specific field log book.

# 6.0 Training

Each field crew member must be trained in the following prior to conducting field work:

- Field safety
- Sampling protocols
- Calibration and operation of turbidimeter and specific conductance meter. Proper recording of data in field log book
- Field quality control samples

Before field crew members are allowed to conduct reportable work, they must demonstrate competence in conducting field analyses. A tenured field crew will ensure that new field crews are competent in all field procedures and test protocols.

## 7.0 Report

MOA will prepare a brief data report following the initial sampling season, provided in the annual report for that year, and combine the results with the data from the second sampling season to create a comparative report of the two snow storage sites with previous year's findings. The final report will include a description of the sampling events, field results, a discussion of the results, and any recommended changes to the protocols for future sampling events. In discussing the results, MOA will:

- Use the correlation developed in 2013 between the laboratory chloride data and the specific conductance for each site to estimate chloride concentrations obtained at the monitoring points.

- Compare the peak chloride concentrations and turbidity to previous results. For the Tudor site, the comparisons will be made with those reported in the data reports from 2000, 2001 and 2013 (MOA, 2000b, 2001, 2013). For the Spruce Street site, data will be compared to results from the 2013 effort. The reports will also discuss similarities and postulate reasons for possible differences.

## 8.0 References


MOA. 1998. Magnesium Chloride Deicer in Snow Disposal Sites at Anchorage, Alaska: Assessment Design. Prepared by Scott Wheaton, Watershed Scientist, WMS. Prepared for Watershed Management Section, Municipality of Anchorage. March 1998.Document No. WMP APd 98001.

MOA. 1999. Meltwater Runoff from Anchorage Streets and Snow Disposal: 1999 Data Report.

Prepared by Montgomery Watson. Prepared for Watershed Management Section, Municipality of Anchorage. October 1999. Document No. WMP APr 99003.

MOA. 2000a. Anchorage Street Deicer and Snow Disposal: 2000 Design Report. Prepared by MWH. Prepared for Watershed Management Section (WMS), Municipality of Anchorage. December 2000. Document No. WMP APd00004.

MOA. 2001. Anchorage Street Deicer and Snow Disposal: 2001 Data Report. Prepared by MWH. Prepared for Watershed Management Section (WMS), Municipality of Anchorage. October 2000. Document No. WMP APr01004.

MOA. 2000b. Anchorage Street Deicer and Snow Disposal: 2000 Data Report. Prepared by MWH. Prepared for Watershed Management Section (WMS), Municipality of Anchorage. December 2000. Document No. WMP APr00004.

MOA. 2013. Anchorage Snow Disposal Sites: 2013 Evaluation. Prepared by Watershed Management Services, Municipality Of Anchorage. January 2014. Document No. WMP ARr14002